Diversity of avian fauna in Karaivetti Bird Sanctuary, Ariyalur District, Tamil Nadu, India

Abstract

Birds serve as key indicators of environmental health, helping to monitor and maintain ecological balance. The study conducted from 2021 to 2024 in the Karaivetti Bird Sanctuary, located in the Ariyalur district, aimed to assess year-wise species diversity, richness, relative diversity, evenness, density, and relative abundance of wetland birds. The total count method was employed to estimate the population of wetland birds. The study at Karaivetti Bird Sanctuary recorded 97 bird species over four years, with 30 migrant and 67 resident species. Among these, five species were Near Threatened viz., Black-tailed Godwit (*Limosa limosa*), Woolly-necked Stork (*Ciconia episcopus*), Spot-billed Pelican (*Pelecanus philippensis*), Black-headed Ibis (*Threskiornis melanocephalus*) and Oriental Darter (*Anhinga melanogaster*) and two were Vulnerable viz., Greater Spotted Eagle (*Clanga clanga*) and Common Pochard (*Aythya ferina*). Comparative studies in other sanctuaries revealed similar patterns in species diversity and abundance. The highest species diversity at Karaivetti was in 2021, while the highest richness occurred in 2022. Total bird density was highest in 2021 and lowest in 2024, with the Little Cormorant showing the highest relative abundance in recent years.

Keywords: - *Wetland, Water birds, Karaivetti Bird Sanctuary, Year-wise variations*

Introduction

Wetlands are transitional zones between permanently aquatic and dry terrestrial ecosystems. Covering roughly 6% of the Earth's land area, wetlands encompass various types including marshes, lagoons, bogs, fens, open water bodies, and mangroves (Ramamurthy and Rajakumar, 2014). According to the Ramsar Convention of the IUCN held in Iran in 1981, a wetland is defined as an “area of marsh, fen, peatland or water whether natural or artificial, permanent or temporary with water, that is static or flowing, fresh, brackish or salt including areas of marine water, the depth of which does not exceed 6 meters” (Ramsar Convention, 2004; Guptha *et al*., 2011). Wetlands are the second most productive ecosystems after tropical rainforests (Ekhande *et al*., 2012) and support migratory and resident avian species, enhancing biodiversity and ecosystem productivity (Gibbs, 1993; Paracuellos, 2006). They serve as crucial bird habitats, providing essential areas for feeding, roosting, and breeding. However,

wetlands face numerous threats, primarily from human activities such as urbanization, agricultural expansion, pollution, drainage for development, and climate change. These activities significantly impact wildlife populations, water quality, hydrological cycles, and other vital wetland functions.

Migratory species are particularly vulnerable because they rely on different sites and habitats during breeding and non-breeding seasons; a threat to any one of these areas can have substantial consequences (Salathe, 1991). Habitat destruction is a primary cause of bird population decline, with over 90% of globally threatened birds and 86% of other bird species facing serious threats mainly due to habitat degradation (Kauzeni and Kiwasila, 1994; Kideghesho *et al*., 2006). Information on the status and distribution of threatened and endemic birds is crucial for predicting disturbance levels and implementing conservation measures at potential sites. In 2000, the 'Threatened Birds of the World' listed 1,186 species worldwide, including 123 species in India (Kaur and Brraich, 2021). Preserving wetlands is therefore critical to protecting endangered and threatened species (Abir *et al*., 2014). The Karaivetti Bird Sanctuary is a vital habitat for numerous wetland birds, including threatened and migratory species. Despite its significance, there has been a noticeable lack of systematic studies focusing on wetland birds, particularly regarding yearly patterns, diversity, evenness, richness, and density. Therefore, this study aims to conduct an inventory of wetland birds within the Karaivetti Bird Sanctuary.

Materials and Methods

Study Area

The Karaivetti Bird Sanctuary, located in the Ariyalur District of Tamil Nadu, India, was designated as a protected area in 1999. Spanning approximately 4.52 km², this sanctuary is a crucial habitat for a diverse range of bird species. It is situated at coordinates 10.8741° N latitude and 79.1892° E longitude. The site is one of the largest inland freshwater lakes in the state of Tamil Nadu. It serves as a crucial stopover and foraging ground for birds migrating along the Central Asian Flyway. Approximately 10,000 individuals of 14 colonial waterbird species have been found nesting here. The gum Arabic tree (*Acacia nilotica*) provides essential roosting and nesting grounds for threatened species such as the spotted eagle (*Aquila clanga*), tawny eagle (*Aquila rapax*), and Indian darter (*Anhinga melanogaster*). When the water level starts receding after January, larger birds such as the painted stork (*Mycteria leucocephala*) flock to the site, which has recorded one of the largest congregations of waterbirds among all lakes in Tamil Nadu. The site also provides a breeding habitat for the vulnerable

Indian flap-shelled turtle (*Lissemys punctata*). The water level of the site is maintained with water from the Mettur Dam. The lake water is also used to irrigate about 4,000 hectares of surrounding farmland.

Bird Survey Method

The field survey was conducted over the past four years, from 2021 to 2024, utilizing the total count method. Researchers walked within and around the wetlands or stationed themselves at specific vantage points to observe and count all birds whenever feasible (Gupta *et al.,* 2011). Surveys were conducted every month during the dawn and dusk periods, from 6:30 am to 10:00 am and 4:00 pm to 6:30 pm. Binoculars (Nikon 7x50) were used for observations, and bird photography was facilitated with a Nikon P900 camera. Bird identification was corroborated with the assistance of reference books such as "Birds of the Indian Subcontinent" (Grimmett *et al.,* 1999) and "The Book of Indian Birds" by Salim Ali (1996).

Data Analysis

Shannon-Weiner index of diversity (Shannon and Weiner, 1963) was used to assess the bird species diversity in Karaivetti Bird Sanctuary.

The formula for calculating the Shannon diversity index is

$$H' = -\sum Pi \, Ln \, Pi$$

Where H' = Shannon index of diversity, Pi = the proportion of the i^{th} species in the landscape element and Ln Pi = Natural logarithm of the proportion of each species.

Richness was calculated by counting the number of species observed in a particular season and particular place (Harisha and Hosetti, 2009).

Species richness = Number of species recorded

Pielou's evenness index was utilized to estimate the species' evenness within the Karaivetti Bird Sanctuary. This index provides a measure of how evenly distributed the individuals are among different species, indicating the level of evenness in the community (Ekhande *et al.,* 2012).

$$\text{Evenness/Equitability} = H'/H'max$$

Where, H' = Value recorded from Shannon-Weiner diversity index and H' max = Maximum possible value of H'.

The Relative Abundance (Anjos, 2004; Ayenalem & Bekele, 2008) was analyzed from the collected data during the study period using the following formula:

$$\text{Relative Abundance} = \frac{\text{Number of individual species}}{\text{}} \times 100$$

Number of individuals of all species

The density is an utterance of the numerical strength of a particular species where the total number of individuals of each species in a particular season is divided by the total area of the wetland (Ramamurthy and Rajakumar, 2014).

Results and Discussion

The current study recorded a total of 97 bird species from 15 orders and 36 families over the last four years in Karaivetti Bird Sanctuary. Of these, 30 species were migrants, and the remaining 67 were residents. Five species were classified as Near Threatened: the Black-tailed Godwit (*Limosa limosa*), Woolly-necked Stork (*Ciconia episcopus*), Spot-billed Pelican (*Pelecanus philippensis*), Black-headed Ibis (*Threskiornis melanocephalus*), and Oriental Darter (*Anhinga melanogaster*). Additionally, two species were categorized as Vulnerable: the Greater Spotted Eagle (*Clanga clanga*) and Common Pochard (*Aythya ferina*). Ninety species were listed as Least Concern. A previous study was conducted by Baranidharan *et al.* (2022) who recorded 36 species of wetland birds belonging to 13 families and 4 orders in Karaivetti Bird Sanctuary. Among these, six Near Threatened species were observed, including the Oriental Darter (*A. melanogaster*), Painted Stork (*M. leucocephala*), Spot-billed Pelican (*P. philippensis*), Woolly-necked Stork (*C. episcopus*), Black-headed Ibis (*T. melanocephalus*), and Black-tailed Godwit (*L. limosa*), as well as one Vulnerable species, the River Tern (*Sterna aurantia*). A similar study by Krishnamoorthi *et al*. (2020) in the Vellode Bird Sanctuary found 72 bird species across 38 families and 17 orders, with three Near Threatened species: the Oriental Darter (*A. melanogaster*), Painted Stork (*M. leucocephala*), and Spot-billed Pelican (*P. philippensis*). Furthermore, Vas *et al.* (2023) analyzed Neyveli Lignite Corporation India Limited (NLCIL) in Neyveli, Tamil Nadu, identifying 107 different bird species comprising 21 orders and 45 families, with three Near Threatened species.

Table 1. Year-wise avian species diversity, total density richness and evenness of Karaivetti bird sanctuary

Year	Total density	Richness	Diversity	Evenness
2021	4991.41	58	2.75	0.27
2022	4773.35	78	2.12	0.21
2023	4859.25	51	2.72	0.27
2024	1820.04	34	2.21	0.24

Species diversity

Regarding the species diversity in the Karaivetti bird sanctuary during different years, the highest species diversity was recorded in 2021 (2.75) followed by 2023 (2.72) and 2024 (2.21) while the lowest species diversity was obtained in 2022 (2.12). Similar findings were reported by Satheesh *et al.* (2024) in their analysis of species diversity in the Udhayamarthandapuram Bird Sanctuary, Tamil Nadu. They noted that the maximum diversity was observed in 2021 (2.75), while the minimum diversity was recorded in 2024 (1.64). From the current study, the maximum richness was observed in 2022 (78) followed by 2021 (58) and 2023 (51) while the minimum species richness was recorded in 2024 (34). A similar finding was found by Manohara *et al.* (2016) in the Magadi bird sanctuary, Karnataka with maximum species richness observed in 2012-13 (33) and minimum in 2015-16 (27). Concerning the evenness of the Karaivetti bird sanctuary the highest evenness was obtained during 2021 and 2023 (0.27) followed by 2024 (0.24) whereas the lowest evenness was recorded during 2022 (0.21) (Table 1 & Figures 1 & 2). The results were consistent with the findings of Satheesh *et al.* (2024), who observed maximum evenness in 2024 (0.37) and minimum evenness in 2023 (0.21) in Vaduvoor Bird Sanctuary.

Total density

The current investigation revealed that the highest total bird density in Karaivetti Bird Sanctuary was recorded in 2021 (4991.41/km²), followed by 2023 (4773.35/km²) and 2022 (4773.35/km²), with the lowest density observed in 2024 (1820.04/km²) (Table 1 & Figure 2). This result aligns with the findings of Krishnamoorthi *et al.* (2020), who noted that the maximum total density was observed during the monsoon season (1556.99/km²), while the lowest density was recorded during the winter season (948.18/km²). In 2021, the maximum species density was for the Glossy Ibis (866.079/km²), followed by the Little Cormorant (851.762/km²), Little Egret (621.366/km²), White Ibis (424.449/km²), and Cattle Egret (401.762/km²). In 2022, the highest species density was observed for the Little Cormorant (1753.30/km²), followed by the Little Egret (1228.85/km²), Glossy Ibis (496.92/km²), and Eurasian Coot (179.30/km²). In 2023, the maximum species density was found in the Little Cormorant (1148.68/km²), followed by the Little Egret (840.31/km²), Cattle Egret (267.84/km²), and White Ibis (246.92/km²). In 2024, the highest species density was registered for the Little Cormorant (696.04/km²), followed by the Glossy Ibis (253.30/km²), Little Egret (246.70/km²), White Ibis (171.8/km²), and Open Bill Stork (90.31/km²) (Tables 2, 3, 4 & 5). These findings are consistent with the previous study of Baranidharan *et al.* (2022), who stated that the maximum density in the Karaivetti Bird Sanctuary was recorded for the Large Egret

(57/km²), followed by the Cattle Egret (56/km²), Little Cormorant (50/km²), and Spot-billed Duck (32/km²), with the lowest densities observed for the Darter, Purple Heron, Eurasian Spoonbill, and Common Teal (1.5/km²).

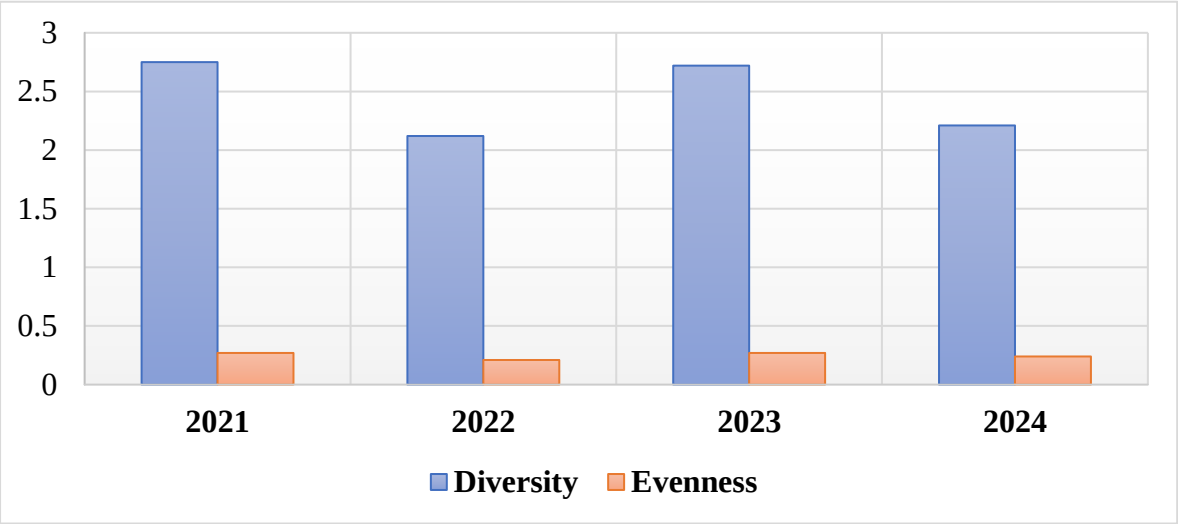

Figure 1. Year-wise avian diversity and evenness of Karaivetti bird sanctuary

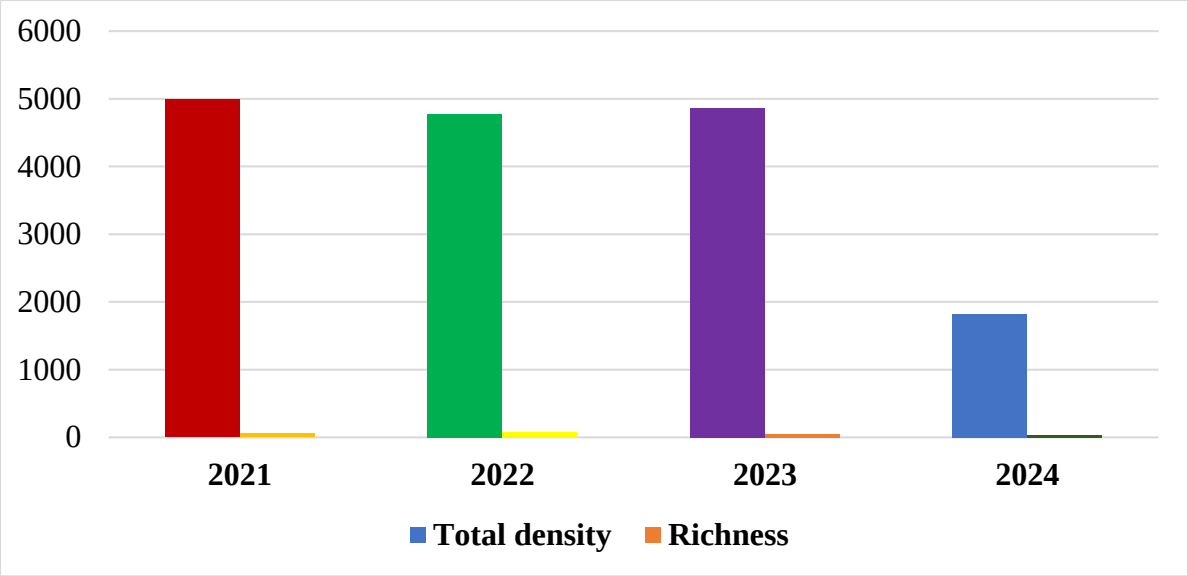

Figure 2. Year-wise avian density and richness of Karaivetti bird sanctuary

Relative abundance

From this study, the highest relative abundance in 2021 was observed in the Glossy Ibis (17.35%), followed by the Little Cormorant (17.06%), Little Egret (12.45%), White Ibis (8.50%), and Cattle Egret (8.049%). In 2022, the maximum relative abundance was recorded in the Little Cormorant (36.73%), followed by the Little Egret (25.74%), Glossy Ibis (10.41%), and Eurasian Coot (3.76%). In 2023, the highest relative abundance was noted in the Little Cormorant (23.64%), followed by the Little Egret (17.29%), Cattle Egret (5.51%), and White

Ibis (5.08%). In 2024, the maximum relative abundance was observed in the Little Cormorant (38.24%), followed by the Glossy Ibis (13.92%), Little Egret (13.55%), White Ibis (9.44%), and Open Bill Stork (4.96%) (Tables 2, 3, 4, & 5). Similar findings were recorded by Satheesh *et al.* (2024) in Vaduvoor Bird Sanctuary, where the maximum relative abundance was noted in the Black-headed Ibis (43.32%), while the minimum (0.004%) was observed for the Cinnamon Bittern, Wood Sandpiper, Glossy Ibis, Yellow Bittern, Ruff, Indian Paradise Flycatcher, Crested Serpent Eagle, Indian Pitta, Western Marsh Harrier, and Jerdon's Bushlark in 2022. Bibi *et al*. (2003) reported comparable findings in the Taunsa Barrage Wildlife Sanctuary, Pakistan, where they observed the Eurasian Coot as the most abundant species (13.3%), followed by the Cattle Egret (12.3%), Little Egret (11.5%), Common Pochard (8.9%), and House Crow (5.8%).

Table 2. Avian density and relative abundance during 2021 of Karaivetti Bird Sanctuary

S.No.	Species Name	Density (km^2)	Relative Abundance (%)
1.	Little grebe	46.256	0.927
2.	Grey Pelican	3.965	0.079
3.	Little cormorant	851.762	17.065
4.	Great cormorant	2.863	0.057
5.	Oriental Darter	27.974	0.560
6.	Little egret	621.366	12.449
7.	Grey heron	7.048	0.141
8.	Purple heron	25.991	0.521
9.	Large egret	51.322	1.028
10.	Median egret	42.291	0.847
11.	Cattle egret	401.762	8.049
12.	Pond heron	51.101	1.024
13.	Little Green heron	0.220	0.004
14.	Night heron	28.194	0.565
15.	Chestnut bittern	0.661	0.013
16.	Painted stork	26.872	0.538
17.	Open bill stork	67.621	1.355
18.	White necked stork	2.423	0.049
19.	White ibis	424.449	8.504
20.	Spoonbill	4.626	0.093
21.	Glossy ibis	866.079	17.351
22.	Bar Headed Goose	55.947	1.121
23.	Comb duck	0.220	0.004
24.	Cotton teal	49.119	0.984
25.	Spot –bill duck	194.053	3.888
26.	Shoveller	49.339	0.988
27.	Pintail Duck	272.907	5.468
28.	Garganey	5.947	0.119
29.	Common teal	182.599	3.658
30.	Lesser whistling teal	48.238	0.966

31.	Common pochard	1.982	0.040
32.	Wigeon	0.220	0.004
33.	White breasted waterhen	7.709	0.154
34.	Purple moorhen	28.414	0.569
35.	Common moorhen	5.507	0.110
36.	Common coot	160.132	3.208
37.	Pheasant-tailed jacana	4.846	0.097
38.	Bronze-winged jacana	1.762	0.035
39.	Greater painted -snipe	2.643	0.053
40.	Plover	3.304	0.066
41.	Yellow-wattled lapwing	2.863	0.057
42.	Red- wattled lapwing	13.436	0.269
43.	Grey-Headed Lapwing	0.220	0.004
44.	Black tailed godwit	1.322	0.026
45.	Whimbrel	2.643	0.053
46.	Redshank	4.626	0.093
47.	Greenshank	4.185	0.084
48.	Marsh sandpiper	29.075	0.582
49.	Wood sandpiper	0.220	0.004
50.	Common Sandpiper	8.150	0.163
51.	Little stint	116.300	2.330
52.	Black winged stilt	115.859	2.321
53.	Black-headed gull	0.220	0.004
54.	Little tern	47.137	0.944
55.	Whisked tern	0.220	0.004
56.	Small blue kingfisher	3.744	0.075
57.	Pied Kingfisher	6.388	0.128
58.	White-breasted Kingfisher	5.066	0.101

Table 3. Avian density and relative abundance during 2022 of Karaivetti Bird Sanctuary

S.No.	Species Name	Density (km^2)	Relative Abundance (%)
1.	Spot billed Pelican	3.30	0.07
2.	Bar Headed Goose	18.06	0.38
3.	Eurasian Wigeon	16.74	0.35
4.	Indian Spot billed Duck	69.38	1.45
5.	Lesser Whistling Duck	29.74	0.62
6.	Fulvous whistling duck	10.35	0.22
7.	Northern Pintail	85.02	1.78
8.	Garganey	24.23	0.51
9.	Northern Shoveller	92.73	1.94
10.	Common Teal	72.03	1.51
11.	Little Grebe	27.97	0.59
12.	Little Cormorant	1753.30	36.73
13.	Large cormorant	5.51	0.12
14.	Indian Cormorant	18.06	0.38
15.	Oriental Darter	19.38	0.41
16.	Indian Pond Heron	25.33	0.53
17.	Black-crowned Night Heron	7.71	0.16

18.	Cattle Egret	77.53	1.62
19.	Little Egret	1228.85	25.74
20.	Intermediate Egret	42.95	0.90
21.	Great Egret	5.51	0.12
22.	Purple Heron	2.20	0.05
23.	Grey Heron	7.05	0.15
24.	Black-headed Ibis	272.03	5.70
25.	Spoonbill	18.72	0.39
26.	Glossy Ibis	496.92	10.41
27.	Painted Stork	1.32	0.03
28.	Asian Openbill	40.75	0.85
29.	Woolly-necked Stork	0.44	0.01
30.	White-breasted Waterhen	1.76	0.04
31.	Common Sandpiper	1.54	0.03
32.	Green Sandpiper	1.32	0.03
33.	Wood Sandpiper	0.66	0.01
34.	Little Ringed Plover	0.88	0.02
35.	Red Wattled Lapwing	7.93	0.17
36.	Pheasant-tailed Jacana	1.76	0.04
37.	Purple Swamphen	0.88	0.02
38.	Common Moorhen	0.44	0.01
39.	Eurasian Coot	179.30	3.76
40.	Black-winged Stilt	25.33	0.53
41.	Gull-Billed Tern	0.88	0.02
42.	Greater Spotted Eagle	0.44	0.01
43.	Osprey	0.44	0.01
44.	Black Kite	0.66	0.01
45.	Brahminy Kite	1.10	0.02
46.	Eurasian Marsh Harrier	0.66	0.01
47.	Shikra	0.66	0.01
48.	Spotted Dove	1.10	0.02
49.	Rock Pigeon	1.54	0.03
50.	Rose-ringed Parakeet	1.32	0.03
51.	Common Hawk Cuckoo	0.66	0.01
52.	Jacobin Cuckoo	0.44	0.01
53.	Greater Coucal	0.66	0.01
54.	Grey Francolin	0.66	0.01
55.	Indian Peafowl	0.66	0.01
56.	Ashy-crowned Sparrow Lark	1.10	0.02
57.	Paddyfield Pipit	1.10	0.02
58.	Blyth's Reed Warbler	0.66	0.01
59.	Clamorous Reed Warbler	0.44	0.01
60.	Asian Palm Swift	7.49	0.16
61.	Barn Swallow	16.74	0.35
62.	White-throated Kingfisher	1.54	0.03
63.	Common Kingfisher	1.10	0.02
64.	Pied Kingfisher	1.10	0.02

65.	Green Bee-eater	8.37	0.18
66.	Blue-tailed Bee-eater	3.08	0.06
67.	Indian Roller	0.88	0.02
68.	Black Drongo	3.08	0.06
69.	Common Myna	3.30	0.07
70.	Rufous Treepie	0.66	0.01
71.	House Crow	4.41	0.09
72.	Indian Jungle Crow	2.20	0.05
73.	Yellow-billed Babbler	3.30	0.07
74.	Ashy Prinia	0.66	0.01
75.	Plain Prinia	0.22	0.00
76.	White-browed Wagtail	1.10	0.02
77.	Purple-rumped Sunbird	0.66	0.01
78.	Baya Weaver	3.30	0.07

Table 4. Avian density and relative abundance during 2023 of Karaivetti Bird Sanctuary

S.No.	Species Name	Density (km^2)	Relative Abundance (%)
1.	Little grebe	45.15	0.93
2.	Grey Pelican	2.64	0.05
3.	Little cormorant	1148.68	23.64
4.	Great cormorant	1.76	0.04
5.	Darter	26.65	0.55
6.	Little egret	840.31	17.29
7.	Grey heron	138.33	2.85
8.	Purple heron	68.72	1.41
9.	Large egret	138.33	2.85
10.	Median egret	40.97	0.84
11.	Cattle egret	267.84	5.51
12.	Pond heron	47.36	0.97
13.	Little Green heron	0.22	0.00
14.	Night heron	26.65	0.55
15.	Chestnut bittern	0.22	0.00
16.	Painted stork	25.99	0.53
17.	Open bill stork	65.64	1.35
18.	White necked stork	1.32	0.03
19.	White ibis	246.92	5.08
20.	Spoonbill	3.96	0.08
21.	Glossy ibis	424.01	8.73
22.	Bar Headed Goose	57.71	1.19
23.	Comb duck	0.22	0.00
24.	Cotton teal	47.58	0.98
25.	Spot-billed duck	192.29	3.96
26.	Shoveller	47.36	0.97
27.	Pintail Duck	272.03	5.60
28.	Garganey	5.07	0.10
29.	common teal	181.28	3.73
30.	Lesser whistling teal	47.58	0.98
31.	Common pochard	1.32	0.03

32.	Wigeons	0.22	0.00
33.	White-breasted Waterhen	6.17	0.13
34.	Purple moorhen	26.65	0.55
35.	Common moorhen	4.63	0.10
36.	Common coot	158.81	3.27
37.	Pheasant-tailed jacana	3.96	0.08
38.	Bronze-winged jacana	0.66	0.01
39.	Greater painted-snipe	1.76	0.04
40.	Little Ringed Plover	2.20	0.05
41.	Yellow-wattled lapwing	1.76	0.04
42.	Red-wattled lapwing	12.11	0.25
43.	Grey-Headed Lapwing	0.22	0.00
44.	Black-tailed godwit	0.66	0.01
45.	Whimbrel	1.76	0.04
46.	Redshank	3.96	0.08
47.	Greenshank	3.30	0.07
48.	Marsh sandpiper	26.65	0.55
49.	Wood sandpiper	0.22	0.00
50.	Common Sandpiper	7.27	0.15
51.	Little stint	77.31	1.59

Table 5. Avian density and relative abundance during 2024 of Karaivetti Bird Sanctuary

S.No.	Species Name	Density (km^2)	Relative Abundance (%)
1.	Large Egret	39.65	2.18
2.	Cattle Egret	48.46	2.66
3.	Little Egret	246.70	13.55
4.	Little Grebe	14.76	0.81
5.	Little Cormorant	696.04	38.24
6.	Grey Heron	37.44	2.06
7.	Pond Heron	17.62	0.97
8.	White Necked Stork	0.44	0.02
9.	Open Bill Stork	90.31	4.96
10.	Painted Stork	6.61	0.36
11.	White Headed Ibis	171.81	9.44
12.	Glossy Ibis	253.30	13.92
13.	Darter	13.00	0.71
14.	Red Wattled Lapwing	15.20	0.84
15.	Spoon Bill	5.51	0.30
16.	Wigeon	3.30	0.18
17.	Common Sand Piper	3.30	0.18
18.	Purple Heron	5.51	0.30
19.	Common Coot	10.79	0.59
20.	Spot Bill Duck	17.62	0.97
21.	Pheasant Tailed Jacana	4.41	0.24
22.	River Term	13.22	0.73
23.	Wood Sandpiper	5.29	0.29
24.	Black Winged Stilt	16.52	0.91
25.	Yellow Wattled Lapwing	1.10	0.06

26.	Spot Billed Pelican	6.61	0.36
27.	Garganey	18.72	1.03
28.	Purple Moorhen	7.71	0.42
29.	Common Teal	9.91	0.54
30.	Cottan Teal	4.41	0.24
31.	Lesser Whistling Duck	10.35	0.57
32.	White Breasted Water Hen	3.30	0.18
33.	Northern Shoveller	14.54	0.80
34.	Bar Headed Goose	6.61	0.36

Conclusion

The study conducted over four years in Karaivetti Bird Sanctuary recorded 97 bird species, including migrant and resident species. Five species were Near Threatened, and two were Vulnerable according to the IUCN Red List. It serves as a foundational reference for understanding population dynamics, habitat preferences, and conservation priorities within the sanctuary and potentially informs broader conservation strategies for wetland ecosystems. Comparison with previous studies highlighted the sanctuary's regional importance for avian diversity. Fluctuations in species diversity, richness, and evenness across years emphasized the need for ongoing conservation efforts. Overall, these findings not only contribute to the scientific understanding of avian ecology but also have implications for the conservation and management of Karaivetti Bird Sanctuary and similar habitats. Continued research and monitoring efforts are essential for ensuring the preservation of biodiversity in the face of environmental challenges.

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Appendix 1. Species composition of wetland birds and wetland-associated birds of Karaivetti Bird Sanctuary

S.No	Order	Family	Species	Scientific name	IUCN status	Migratory status	2021	2022	2023	2024
1.	Accipitriformes	Accipitridae	Black Kite	*Milvus migrans*	LC	R		✓		
2.			Brahminy Kite	*Haliastur Indus*	LC	R		✓		
3.			Eurasian Marsh Harrier	*Circus aeroginosus*	LC	M		✓		
4.			Greater Spotted Eagle	*Aquila clanga*	VU	M		✓		
5.			Shikra	*Accipiter badius*	LC	R		✓		
6.		Pandionidae	Osprey	*Pandion haliaetus*	LC	M		✓		
7.	Anseriformes	Anatidae	Bar Headed Goose	*Anser indicus*	LC	M	✓	✓	✓	✓
8.			Comb duck	*Sarkidiornis melanatos*	LC	R	✓	✓	✓	
9.			Common pochard	*Aythya farina*	VU	M	✓	✓	✓	
10.			Common Teal	*Anas crecca*	LC	M	✓	✓	✓	✓
11.			Cotton teal	*Nattapus coromandelianus*	LC	R	✓	✓	✓	
12.			Eurasian Wigeon	*Anas Penelope*	LC	M				✓
13.			Fulvous whistling duck	*Dendrocygna bicolor*	LC	R				✓
14.			Garganey	*Anas querquedula*	LC	M	✓	✓	✓	✓
15.			Indian Spot billed Duck	*Anas poecilorhyncha*	LC	R	✓	✓	✓	✓
16.			Lesser Whistling Duck	*Dendrocygna javanica*	LC	R	✓	✓	✓	✓
17.			Northern Pintail	*Anas acuta*	LC	M	✓	✓	✓	✓
18.	Anseriformes	Anatidae	Northern Shoveller	*Anas clypeata*	LC	M	✓	✓	✓	✓
19.			Wegion	*Mareca penelope*	LC	M	✓	✓	✓	
20.	Caprimulgiformes	Apodidae	Asian Palm Swift	*Cypsiurus balasiensis*	LC	R				✓
21.		Charadriidae	Grey-Headed Lapwing	*Vanellus cinereus*	LC	M	✓	✓	✓	
22.			Little Ringed Plover	*Charadrius dubius*	LC	R	✓	✓	✓	✓
23.			Red Wattled Lapwing	*Vanellus indicus*	LC	R	✓	✓	✓	✓
24.			Yellow-wattled lapwing	*Vanellus malabaricus*	LC	R	✓	✓	✓	

25.	Charadriiformes	Jacanidae	Bronze winged jacana	*Metopidius indicus*	LC	R	✓	✓	✓	
26.			Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	LC	R	✓	✓	✓	✓
27.		Laridae	Black headed gull	*Chroicocephalus ridibundus*	LC	M	✓		✓	
28.			Gull-billed tern	*Gelochelidon nilotica*	LC	M				✓
29.			Little tern	*Sternula albifrons*	LC	R	✓		✓	
30.			Whisked tern	*Childonias hybrida*	LC	M	✓		✓	
31.		Recurvirostridae	Black-winged Stilt	*Himantopus himantopus*	LC	M	✓	✓	✓	✓
32.		Rostratulidae	Greater painted snipe	*Rostratula benghalensis*	LC	R	✓	✓	✓	
33.		Scolopacidae	Black tailed godwit	*Limosa limosa*	NT	M	✓	✓	✓	
34.	Charadriiformes	Scolopacidae	Common Sandpiper	*Actitis hypoleucos*	LC	M	✓	✓	✓	✓
35.			Green Sandpiper	*Tringa ocropus*	LC	M				✓
36.			Greenshank	*Tringa nebularia*	LC	M	✓	✓	✓	
37.			Little stint	*Calidris minuta*	LC	M	✓	✓	✓	
38.			Marsh sandpiper	*Tringa stagnatilis*	LC	M	✓	✓	✓	
39.			Redshank	*Tringa totanus*	LC	M	✓	✓	✓	
40.			Whimbrel	*Numenius phaeopus*	LC	M	✓	✓	✓	
41.			Wood Sandpiper	*Tringa glareola*	LC	M	✓	✓	✓	✓
42.	Ciconiiformes	Ciconiidae	Asian Openbill	*Anastomus oscitans*	LC	R	✓	✓	✓	✓
43.			Painted Stork	*Mycteria leucocephala*	LC	R	✓	✓	✓	✓
44.			Woolly-necked Stork	*Ciconia episcopus*	NT	R	✓	✓	✓	✓
45.	Columbiformes	Columbidae	Rock Pigeon	*Columba livia*	LC	R		✓		
46.			Spotted Dove	*Streptopelia chinensis*	LC	R		✓		
47.	Coraciiformes	Alcedinidae	Common Kingfisher	*Alcedo atthis*	LC	R	✓		✓	✓
48.			Pied Kingfisher	*Ceryle rudis*	LC	R	✓		✓	✓
49.			White-throated Kingfisher	*Halcyon smyrnensis*	LC	R	✓		✓	✓
50.		Coraciidae	Indian Roller	*Coracias benghalensis*	LC	R				✓

51.		Meropidae	Blue-tailed Bee-eater	*Merops philippinus*	LC	M		✓		
52.			Green Bee-eater	*Merops orientalis*	LC	R		✓		
53.	Cuculiformes	Cuculidae	Common Hawk Cuckoo	*Hierococcyx varius*	LC	R		✓		
54.			Greater Coucal	*Centropus sinensis*	LC	R		✓		
55.			Jacobin Cuckoo	*Clamator jacobinus*	LC	R		✓		
56.	Galliformes	Phasianidae	Grey Francolin	*Francolinus pondecerianus*	LC	R				✓
57.			Indian Peafowl	*Pavo cristatus*	LC	R				✓
58.	Gruiformes	Rallidae	Common Moorhen	*Gallinula chloropus*	LC	R	✓	✓	✓	✓
59.			Eurasian Coot	*Fulica atra*	LC	R	✓	✓	✓	✓
60.			Purple Swamphen	*Porphyrio porphyrio*	LC	R	✓	✓	✓	✓
61.			White-breasted Waterhen	*Amaurornis phoenicurus*	LC	R	✓	✓	✓	✓
62.	Passeriformes	Acrocephalidae	Blyth's Reed Warbler	*Acrocephalus dumetorum*	LC	M				
63.			Clamorous Reed Warbler	*Acrocephalus stentoreus*	LC	M			✓	
64.		Alaudidae	Ashy-crowned Sparrow Lark	*Erymopterix griseus*	LC	R			✓	
65.		Cisticolidae	Ashy Prinia	*Prinia socialis*	LC	R			✓	
66.			Plain Prinia	*Prinia inornata*	LC	R			✓	
67.		Corvidae	House Crow	*Corvus splendens*	LC	R			✓	
68.			Indian Jungle Crow	*Corvus culminatus*	LC	R			✓	
69.			Rufous Treepie	*Dendrocitta vagabunda*	LC	R			✓	
70.		Dicruridae	Black Drongo	*Dicrurus macrocercus*	LC	R			✓	
71.		Hirundinidae	Barn Swallow	*Hirundo rustica*	LC	M			✓	
72.		Leiothrichidae	Yellow-billed Babbler	*Argya affinis*	LC	R			✓	
73.		Motacillidae	Paddyfield Pipit	*Anthus rufulus*	LC	R			✓	
74.			White-browed Wagtail	*Motacilla maderaspatensis*	LC	R			✓	✓
75.		Nectariniidae	Purple-rumped Sunbird	*Leptocoma zeylonica*	LC	R		✓		
76.		Ploceidae	Baya Weaver	*Ploceus philippensis*	LC	R				✓

77.		Sturnidae	Common Myna	*Acridotheres tritis*	LC	R		✓		
78.	Pelecaniformes	Ardeidae	Black-crowned Night Heron	*Nycticorax nycticorax*	LC	R	✓	✓	✓	✓
79.			Cattle Egret	*Bubulcus ibis*	LC	R	✓	✓	✓	✓
80.			Cinnamon bittern	*Ixobrychus cinnamomeus*	LC	R	✓	✓	✓	
81.			Great Egret	*Ardea alba*	LC	R	✓	✓	✓	✓
82.			Grey Heron	*Ardea cinerea*	LC	R	✓	✓	✓	✓
83.			Indian Pond Heron	*Ardeola grayii*	LC	R	✓	✓	✓	✓
84.			Intermediate Egret	*Ardea intermedia*	LC	R	✓	✓	✓	✓
85.			Little Egret	*Egretta garzetta*	LC	R	✓	✓	✓	✓
86.			Little Green heron	*Butorides virescens*	LC	M	✓	✓	✓	
87.			Purple Heron	*Ardea purpurea*	LC	R	✓	✓	✓	✓
88.		Pelecanidae	Spot billed Pelican	*Pelecanus philippensis*	NT	R	✓	✓	✓	✓
89.		Threskiornithidae	Black-headed Ibis	*Threskiornis melanocephalus*	NT	R	✓	✓	✓	✓
90.			Glossy Ibis	*Plegadis falcinellus*	LC	R	✓	✓	✓	✓
91.			Spoonbill	*Platalea leucorodia*	LC	R	✓	✓	✓	✓
92.	Podicipediformes	Podicipedidae	Little Grebe	*Tachybaptus ruficollis*	LC	R	✓	✓	✓	✓
93.	Psittaciformes	Psittaculidae	Rose-ringed Parakeet	*Psittacula krameri*	LC	R				✓
94.	Suliformes	Anhingidae	Darter	*Anhinga melanogaster*	NT	R	✓	✓	✓	✓
95.		Phalacrocoracidae	Indian Cormorant	*Phalocrocorax fuscicolis*	LC	R				✓
96.			Large cormorant	*Phalacrocorax carbo*	LC	R	✓	✓	✓	✓
97.			Little Cormorant	*Microcarbo niger*	LC	R	✓	✓	✓	✓